Observations of the Leonid Meteors of 1903 *made at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer Royal.*)

Until 4^h A.M. on November 16 meteors were appearing at a regular rate (about twenty per hour), and were easily kept under observation by Messrs. Showell and Parkinson, the two observers on duty. At 4^h, as there appeared to be no prospect of a shower, observations were suspended. Shortly afterwards an increase in the rate of appearance took place, and between 4^h 30^m and 5^h A.M. it was estimated by Mr. Furner that meteors were falling at the rate of about eighty per hour; a result closely confirmed by the regular observers on duty, who resumed observing from 5^h 54^m till 6^h 16^m A.M. During the night's watch (about five hours) the number of observations amounted to 107, nearly 90 per cent. of which were *Leonids*.

It should be added that Mr. Crommelin, who was on duty with the altazimuth on November 15 from 4^h 30^m to 6^h 0^m (civil time), and was looking at the sky fairly continuously during the time, saw no meteors.

The morning of November 17 was cloudy.

Royal Observatory, Greenwich:
1903 *December* 8.

The Shower of Leonids in 1903. By W. F. Denning.

A strikingly abundant display of these meteors occurred on the morning of Monday, November 16. Watching the clear north-eastern sky between 12^h and 14^h (November 15) I found the horary number of *Leonids* about eighteen for one observer, while from 14^h to 16^h the rate increased to fifty. Between 16^h and 18^h there was a further rise to about 130 per hour. The maximum was from 17^h 30^m to 17^h 45^m, when forty-two were counted. Between 17^h 30^m and 18^h 5^m the rate of apparition must have exceeded 200 per hour for one observer watching the sky from a good open position. Here the view is somewhat restricted by trees and buildings, so that the meteors enumerated were certainly less than the numbers actually visible under the best circumstances. The shower was about five times as rich as a normal display of *Perseids*.

I counted the meteors at alternate intervals of 15^m, so that I might not only be able to trace the strength of the shower, but also to record some of the brighter objects and note special features. The following is a summary of the chief results.

The meteors were bright generally, and nearly all 1st and 2nd mags. Few, however, were of sufficient brilliancy to outshine *Venus*. Perhaps about one in twenty-five appeared as bright as *Jupiter*, while one in 100 was equal to *Venus*. In the showers of August *Perseids* and November *Andromedids* a considerable number of very small meteors are intermingled with the more brilliant members, but in this respect they offer a marked distinction to the *Leonids*.

The radiant was diffused over an area of about 6°, though a large proportion of the flights were accurately directed from a central point at 151°+22°. Many short and well-observed paths in and near the sickle showed the dispersion very distinctly from R.A. 147° to 155° and Dec. +20° to 26°.

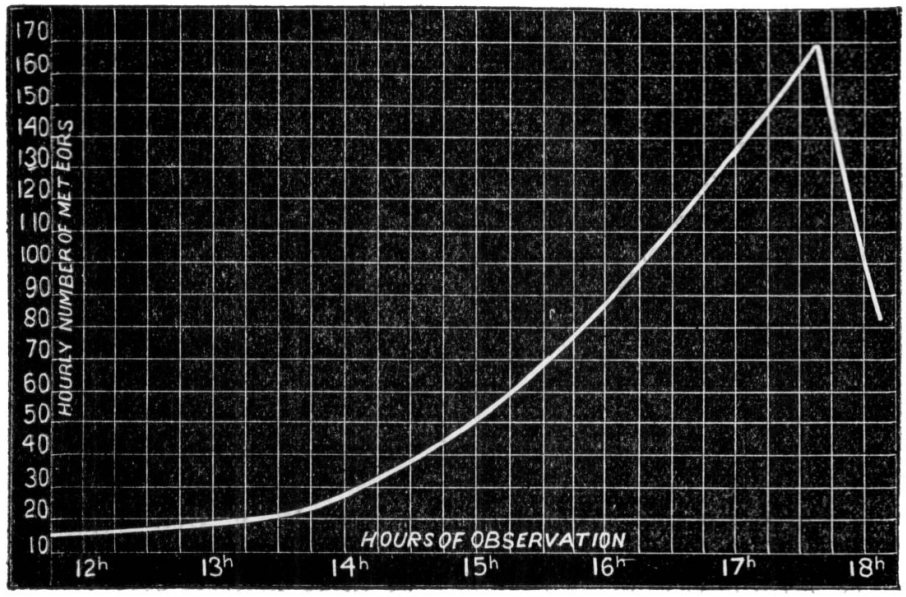

FIG. 1.—Hourly number of meteors seen by one observer. 1903 November 15, 12^h to 18^h.

In the majority of instances the apparent motions were "very swift" or "swift," but the velocities varied in a manner which could hardly be explained by differences in the individual distances or in the angles under which the lines of flight were presented. Several *Leonids* seen here when the radiant was low were described as "slow" or "rather slow," and if at ordinary heights, they could scarcely have travelled with velocities exceeding 30 or 35 miles per second, owing probably to the effects of atmospheric resistance.

The really active portion of the shower was confined to the morning of November 16. On the previous morning I watched a beautifully clear sky for three quarters of an hour (November 14 17^h to 17^h 45^m); but though "the Sickle" was high in the south not a single meteor shot from it, though five were observed from

other directions. On the morning of November 17 the firmament was not very favourable, but during occasional observation

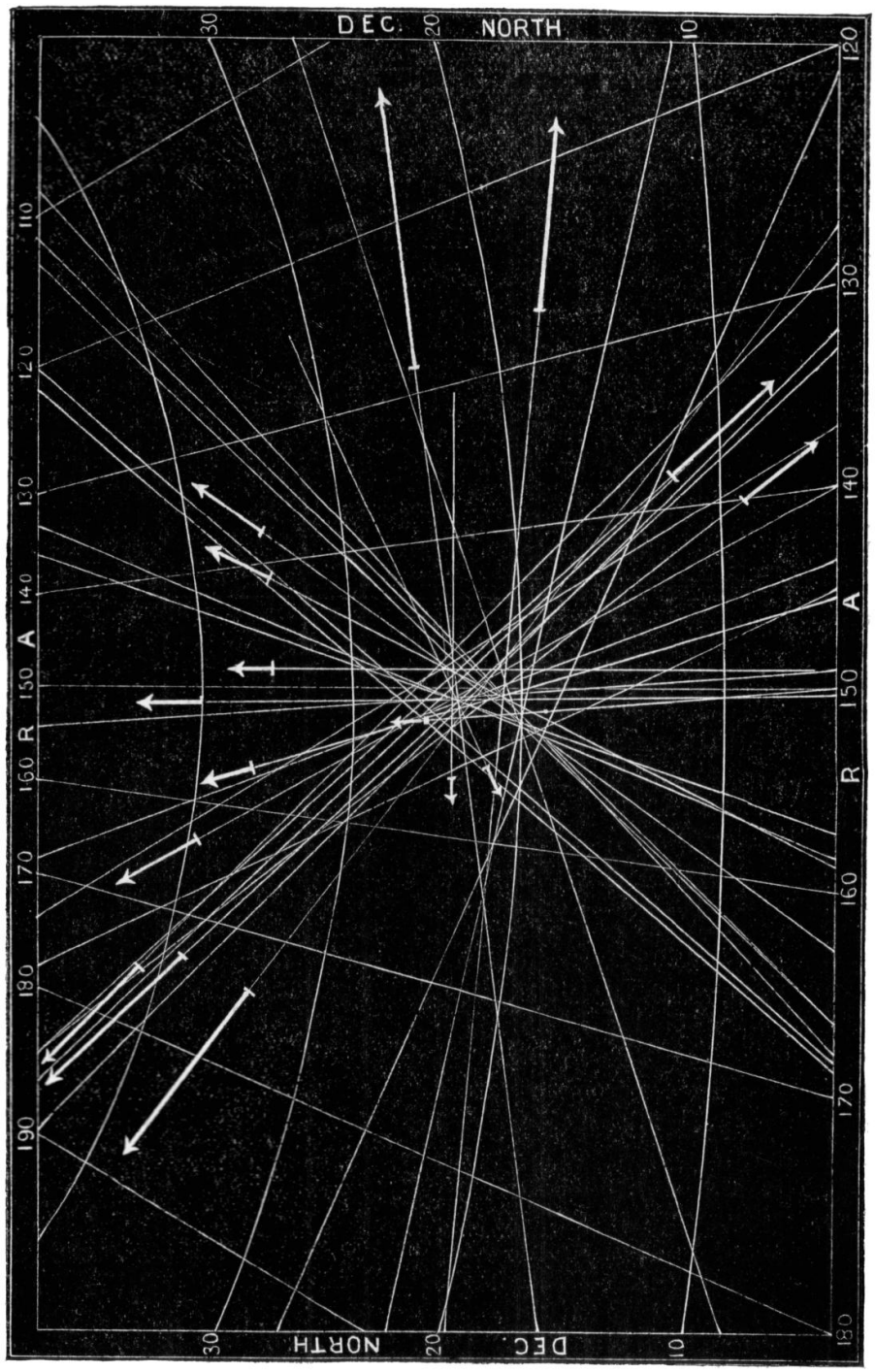

FIG. 2.—The Radiant of the *Leonid* shower, 1903 November 15, 12^h to 18^h

meteors were found to be rare, while the *Leonid* shower afforded only scanty evidence of its presence.

Taking the maximum as having occurred on November 15, $17^h\ 40^m$, the Earth's longitude was 52° 41′, while the bright shower observed in America in 1901 reached a maximum on November 14 at about $22\frac{1}{2}^h$ G.M.T., when the Earth's longitude was 52° 23′. The latter shower appears to have been decidedly stronger than the former, for at the richest time in 1901 various observers found the rate of appearance six or seven per minute. In 1903, during the half-hour when meteors were falling in most plentiful numbers, the rate, as determined under the best surrounding conditions, was about four per minute.

As usual in such displays the meteors came in bursts : two or three were frequently noticed at the same moment pursuing parallel flights in nearly the same region. During the most active period there were successive volleys of four, five, or six. At $16^h\ 45^m$ two bright flashing *Leonids* (one = *Jupiter*, the other > *Venus*) were seen almost at the same instant : one crossed the head of *Auriga* at δ, the other left a streak for more than a minute on the fore paws of *Leo* between *o Leonis* and *ζ Hydræ*.

I observed twenty-seven meteors during the night belonging to the numerous minor showers of the epoch. An exceedingly slow red meteor, of mag. 4, was recorded, at $15^h\ 41^m$, struggling along a short arc from 219°+63° to 209°+61¼° in about three seconds. It very probably belonged to a long-enduring radiant at 262°+62° near *ζ Draconis*. At $15^h\ 59^m$ an unusually slow streak-leaving meteor of mag. 2 traversed a long flight of 45° from 178°+19° to 223°+41° (approximately from *β Leonis* to *β Boötis*). Its visible course may have been even longer than this, for it sailed into my view from behind the corner of a house. The meteor was also seen by Mr. W. Parkinson at the Royal Observatory, Greenwich ; by the Rev. S. J. Johnson at Bridport, Dorset; and by Mr. F. H. Wright, Northampton; and its radiant appears to have been low in the south-eastern sky at 147°−11°. A preliminary determination of the real path indicates the flight, as an extended one of 128 miles, from over Kent to Lincoln, at a height gradually descending from 91 to 45 miles. Velocity about 29 miles per second. At the end of its flight the meteor slowed up considerably, and became almost stationary, as though, its material being well nigh spent, the increasing pressure of the atmosphere had effectually retarded its further progress. Additional observations of this interesting object would be valuable. Its individuality of direction and slow, sailing flight over an extensive arc of the heavens must have caused it to arrest the special notice of many persons who were watching the *Leonid* shower.

Duple or multiple observations of several bright *Leonids* were obtained during the recent display, and the real paths of these will be computed. A 2nd mag. *Leonid* was seen on November 15 $13^h\ 18^m$ by Mr. C. L. Brook at Meltham, near Huddersfield, and also by the writer at Bristol. It fell from a height of 73 to 58 miles, along a path of 36 miles, at a velocity

of about 48 miles per second. The radiant was at 151°+24°. Mr. Brook has also calculated the real path, and makes the height 77 to 61 miles, length of course 34 miles, and velocity 45 miles per second.

For comparison with this and other similar results it may be useful to give the average heights, &c., of seventeen *Leonids* doubly observed in England during the last seven years.

Height at first appearance	84·1 miles
„ disappearance	55·9 „
Length of visible course	45·1 „
Velocity per second	49·8 „
Radiant point	150·65+23·1

Subjoined are the apparent paths of a few bright *Leonids* and of several other shooting stars recorded here during the recent display, and it would be interesting to have duplicate observations of any of these objects.

Date. 1903	G.M.T.	Mag.	Path From α	Path From δ	Path To α	Path To δ	Length.	Duration.	Remarks.	Probable Radiant.
	h m		°	°	°	°	°	sec.		
Nov. 15	12 36	1	122	+24½	103	+23½	17½	1·6	slow, stk.	L.
	12 53	1½	187½	+44	211	+48	17	1·4	slow, stk.	L.
	13 9	3	265	+70	245	+63	10½	1·0	slow	332+71 / 13+39
	13 13	1	119½	+48	97	+53½	15	0·8	v. swift, stk.	L.
	13 35	5	129	+26½	138	+28	8	0·9	slow	Orion
	13 40	3	130	+60	147	+59	8½	1·0	slow	α Aurigæ
	14 32	1½	141½	+35	138½	+39	5	0·5	swift, stk.	L.
	14 36	>1	117½	+26½	98	+26¼	18	0·9	swift, stk.	L.
	14 41	2	32	+71	2	+81	12	0·7	swift	48+43
	14 43	1	162	+38½	168	+44	7	0·6	swift	L.
	14 43	4	73	+72½	17	+63	22	1·2	swift, stk.	L.
	15 9	5	227	+60½	234	+57½	5	0·9	slow	194+67
	15 13	1½	173½	+34½	187	+38½	11½	0·7	slow, stk.	L.
	15 38	4	134	+58½	147	+49	12	1·2	slow	13+39
	15 41	4	219	+63	209	+61¼	5	3·0	v. v. slow	262+62
	15 59	2	178	+19	223	+41	45	5·0	v. v. slow	147−11
	16 4	1	168½	+37	186	+45	15	1·0	swift, stk.	L.
	16 12	4	70	+70	19	+59	23	1·3	swift, stk.	L.
	16 35	2	202	+62	217	+46½	17½	1·3	swift	α Aurigæ
	16 37	4	138	+35	133	+39	6	0·5	swift, stk.	L.
	16 45	4	92	+53	68	+52½	15	0·9	swift, stk.	L.

Date. 1903.	G.M.T. h	m	Mag.	Path From α	Path From δ	Path To α	Path To δ	Length.	Duration. sec.	Remarks.	Probable Radiant.
Nov. 15	16	45	♀	138	+12	134	+7½	6	0·5	swift, stk.	L.
	17	7	4	165½	+41	161½	+36	6	0·5	swift, stk.	177+49
	17	11	1	213	+29	223	+27	9	0·7	swift, stk.	L.
	17	14	4	173	+40½	190	+47	13½	0·9	swift, stk.	L.
	18	5	>4	182	+51	195	+55½	9	0·7	swift, stk.	L.
16	5	59	>1	343	+38½	308	+34	29	3·5	v. slow, yellow train	42+20 58+9

Fig. 1 exhibits the increase in the hourly number observed. This was due to two causes—viz. the much greater density of that part of the stream through which the Earth passed towards 18^h and the improving position (higher altitude) of the radiant as the night progressed.

In fig. 2 the diffuse character of the radiant is shown by the intersecting lines of flight of a number of well-observed *Leonids*. In some cases the meteors appeared outside the limits of the diagram, but their paths have been carried backwards through the radiant.

Bishopston, Bristol: 1903 *November* 25.

Cape Double Star Results, 1903. By R. T. A. Innes.

(*Communicated by Sir David Gill, K.C.B., F.R.S., H.M. Astronomer.*)

The observations in 1903 were confined to a few nights in February and March.

All the measures have been made with the Repsold micrometer on the 18-inch refractor. The assumed value of one revolution of the micrometer screw has been taken as $17''{\cdot}600$.

An explanation of the columns headed "Diff. of Mags." and "Colours" is given on p. 471 of the *Monthly Notices* for 1902 April, vol. lxii.

My measures of double stars with the above instrument extend altogether from 1899 November to 1903 March, and are now brought to a close by my transfer to the Transvaal. My thanks are due to Sir David Gill for his constant encouragement and help, and for the clerical assistance placed at my disposal. The work was greatly facilitated by the mechanical conveniences of the McClean Observatory, the rising floor in particular being of the utmost value for double-star work.